Fletcher, Heald & Hildreth, P.L.C.
1300 North 17th Street 11th floor
Arlington VA 22209
703-812-0400 (voice)
703-812-0486 (fax)

MITCHELL LAZARUS
703-812-0440
LAZARUS@FHHLAW.COM

February 6, 2003

Ed Thomas, Chief
Office of Engineering and Technology
Federal Communications Commission
445 12th Street SW
Washington DC 20554

Re: ET Docket No. 98-153, Ultra-Wideband Transmission Systems
Ex parte Communication

Dear Ed:

On behalf of the XtremeSpectrum, Inc., and pursuant to Section 1.1206(b)(1) of the Commission's Rules, I am filing the attached written *ex parte* communication to respond to certain claims made in this proceeding by Multispectral Solutions, Inc. (MSSI).

If there are any questions about this submission, please contact me at the number above.

Respectfully submitted,

Mitchell Lazarus
Counsel for XtremeSpectrum, Inc.

cc: Office of the Secretary (by electronic filing)
Chairman Michael Powell
Commissioner Kathleen Q. Abernathy
Commissioner Michael J. Copps
Commissioner Kevin J. Martin
Commissioner Jonathan S. Adelstein
Julius P. Knapp, Deputy Chief, OET
Bruce A. Franca, Deputy Chief, OET
Bruce Romano, Associate Chief (Legal), OET
Michael J. Marcus, Associate Chief (Technology), OET
Lisa A. Gaisford, Chief of Staff, OET
Alan J. Scrime, Chief, Policy and Rules Division
Karen Rackley, Chief, Technical Rule Branch
John A. Reed, Senior Engineer, Technical Rules Branch
Ron Chase, Senior Engineer, Technical Analysis Branch
Michael Gallagher, NTIA
Fred Wentland, NTIA
Paul Roosa, NTIA
Ed Drocella, NTIA

Statement in Response to MSSI

MSSI (a) says UWB systems with a high pulse repetition frequency (PRF) are more interfering than those with a low PRF;[1] and (b) criticizes high-PRF bi-phase modulated systems (such as XtremeSpectrum's) as inadequately tested for interference effects.[2]

XtremeSpectrum and others have asserted in the record that high-PRF signals generally minimize the likelihood of potential interference. MSSI asserts the opposite—that low-PRF signals are less interfering than high-PRF signals. These two assertions can be harmonized. At the heart of the disagreement is that fact that the interference impact of high versus low PRF systems depends on the architecture of the victim receiver and on where the interference is measured.

Harm to the detector in a victim receiver is proportional to the peak signal in the resolution bandwidth (RBW) of the victim receiver.[3] A high-PRF signal minimizes this peak to the lowest possible extent in all victim receiver architectures. This is true because a sufficiently high PRF places essentially all victim receivers into the category where the UWB signal appears as noise, characterized by PRF>5*RBW.[4] For example, the high PRF UWB systems manufactured by XtremeSpectrum operate over a range of 1 to 3 GHz PRF. But the widest bandwidths of conventional receivers are less than 100MHz—less than 1/10 the XtremeSpectrum PRF. A low-PRF UWB signal, on the other hand, has a high peak-to-average ratio and creates large spiky peaks, resulting in a higher likelihood of harm at the detector because, quite simply, the peak amplitude at the detector in a victim receiver is larger.

The output of a properly-designed low-PRF UWB transmitter will look like noise to some receivers, but not to others, depending on the receiver's RBW. In those cases where the UWB signal does not look like noise (*e.g.*, low PRF into a wide bandwidth receiver), it instead appears as a series of spiky peaks.[5] These protrude higher than the noise-like signal of a high-PRF UWB transmitter, even when both the high-PRF and low-PRF transmitters are transmitting at the same FCC power limit (i.e. -41.25 dBm/MHz EIRP)[6]. These spikes always cause more interference to the detector inside a victim receiver than the very low-level noise-like signal produced by a high-PRF UWB

[1] Response to Opposition to Petition for Reconsideration of Multispectral Solutions, Inc. (at 3d page, unnumbered) (filed Aug. 2, 2002); Petition for Reconsideration of Multispectral Solutions, Inc. at 9-11 (filed June 14, 2002).

[2] Petition for Reconsideration of Multispectral Solutions, Inc. at 13 (filed June 14, 2002).

[3] This assumes the potentially interfering pulse coming through the antenna is not so large as to drive anything in the receiver into saturation or limiting -- *i.e.*, that the receiver amplifiers, mixers, and detector remain linear.

[4] When PRF>5*RBW, the interference (i.e. peak signal at the detector) grows slowly—as 10*log(RBW)—just like noise.

[5] As the Commission has noted, "pulsed emissions with low PRFs have high peak-to-average ratios and victim receivers will respond to the peak signal level produced by the UWB transmitter if their bandwidth is wider than the UWB PRF." First Report & Order at para. 214.

[6] When PRF<5*RBW, the interference grows quickly—as 20*log(RBW). The low PRF pulses are spaced further apart and are higher, causing larger peaks at the detector.

transmitter. The spikes, if large enough, can cause errors at the detector in the victim receiver. Harm to the functional operation of a radio system typically matches that of the detector.

But there is an exception to this principle, and it lies at the center of the disagreement between whether low PRF or high PRF minimizes the risk of interference. Some advanced receiver systems have non-linear and/or decision-based processing that mitigate errors or noise bursts, as long as those don't occur too often. If the PRF is low enough (*i.e*., if the interfering spikes are spaced far enough apart), the errors induced by the spikes can be masked by the processing. So even though the low PRF signal causes errors at the detector, the processing masks the errors, making the radio appear to be unaffected by the UWB signal. Because the errors are masked, the power of a low-PRF UWB signal can be made higher than that of a high-PRF UWB signal without causing apparent harm to the victim system performance.

Examples of types of processing that can mask bit errors include, among others, forward error correction (FEC), packet based radios that provide for re-sending corrupted packets, and radar systems that require the detector to find a target on "M out of N" radar pulses synchronized to the radar. GPS is an example of such an advanced receiver. It incorporates processing that can tolerate noise bursts, if they don't happen too often.[7] That is why high-power, low-PRF systems can coexist with GPS receivers. [8] But conventional receivers without this processing will continue to suffer greater interference from a low-PRF than a high-PRF UWB transmitter (where both are operating at the same FCC power limit). And even in the case of an advanced receiver system, as above, a low-PRF system can push the error rate beyond the radio's ability to make corrections, especially if background error rates are "using up" the available error-correction capacity.

These facts are the basis for asserting that high-PRF systems, in general, minimize the potential for interference relative to low-PRF UWB.

Ultra-wideband receivers. The Commission's regulations and measurement procedures are based on the assumption that the widest victim receiver bandwidth is 50MHz. But this assumption clearly fails for UWB receivers. UWB systems themselves may also be considered victim receivers and should not be subject to unnecessary harm.[9] High PRF systems present the least chance of harmful interference to other UWB systems because the peaks in the widest variety of the ultra-wide victim receiver architectures are minimized by the high PRF. So a high PRF is not only beneficial for coexistence with conventional radio systems, but high-PRF systems also coexist the best with other UWB systems.

---

[7] The Army Research Lab in Adelphi MD operated a GPS receiver mounted on top of the antennas of a 2MW impulse radar. Because the PRF was only 40 Hz, and the GPS receiver had clean signals from the GPS satellites, it was able to correct the low 40 Hz error rate.
[8] This is consistent with NTIA's finding that low-PRF UWB systems do not interfere with GPS. *Assessment of Compatibility Between Ultrawideband (UWB) Systems and Global Positioning System (GPS) Receivers (Report Addendum)*, NTIA Special Publication 01-47 at xi (November 2001)
[9] Although Part 15 devices such as UWB are required to accept any interference received, 47 C.F.R. Sec. 15.5(b), neither that rule nor any other bars the Commission from considering interference into Part 15 devices as a factor in the public interest.

Effects of modulation. MSSI criticizes high-PRF bi-phase modulated systems (such as XtremeSpectrum's) as inadequately tested for interference. This claim is unfounded on both theoretical and practical levels. Enormous numbers of BPSK (binary phase shift keying) (or bi-phase) and QPSK (quadrature phase shift keying) modulated radios are in common use today. The performance and spectral characteristics of bi-phase modulation are so well known that they can be found in almost any text book on communication theory published in the last 30 years. Moreover, as explained above, the signal from a high-PRF UWB system looks like noise to a victim receiver, and the interference effects of noise have been analyzed very extensively. No further study is needed.

John McCorkle
CTO, XtremeSpectrum, Inc.